POLICY RESEARCH WORKING PAPER 1245

The Adding-Up Problem

Strategies for Primary Commodity Exports in Sub-Saharan Africa

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Policies designed to address the regional adding-up problem in Sub-Saharan Africa — such as a region-optimal export tax — generate unequal benefits among countries. Further, few countries in Sub-Saharan Africa have sufficient market power to influence commodity prices in the long run. Export taxes may prove beneficial for some countries but, at certain levels, transfer resources from smallholders to government with limited welfare gains.

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Summary findings

Many countries in Sub-Saharan Africa remain dependent on a few primary commodities — coffee, cocoa, cotton, sugar, tea, and tobacco — for a large share of export earnings. Because demand for these commodities is price-inelastic, production and export expansion can depress world prices and hence reduce net export revenue. Akiyama and Larson discuss the effects of this phenomenon — the adding-up problem — on policy and development strategies for major agricultural export commodities in Sub-Saharan Africa.

They conclude that, as a practical matter, it is not feasible to design a regional commodity production and trade policy for Sub-Saharan Africa as a whole because of the difficulty of equitably distributing the benefits of such a policy. Moreover, if an export tax is imposed on Sub-Saharan Africa as a whole, the greatest benefits may go to producers in other regions such as Asia and Latin America.

Individually, few countries in Sub-Saharan Africa have sufficient market power to influence commodity prices i the long run. Possible exceptions include Côte d'Ivoire (in cocoa) and to a lesser extent Ghana (in cocoa), Kenya (in tea), and Malawi (in burley tobacco). Export taxes may prove beneficial for these countries but, at certain levels, the primary effect of "optimal" taxes is to transfer resources from smallholders to governments with limited marginal welfare gains.

This paper — a product of the International Trade Division, International Economics Department — is part of a larger effort in the department to assess policy effects on international trade. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Anna Kim, room S7-038, extension 33715 (41 pages). January 1994.

Adding Up Problem -- Strategies for Primary Commodity Exports in Sub-Saharan Africa

By

Takamasa Akiyama and Donald F. Larson

Summary

Sub-Saharan Africa remains dependent on a few primary commodities for a large share of its export earnings--coffee, cocoa, cotton, sugar, tea and tobacco. Several countries are almost exclusively dependent on one or two of these commodities. Because these commodities face a relatively price-inelastic demand, production decisions by individual countries can affect world prices even when their market share is relatively low. This characteristic complicates investment decisions for producers and policy decisions for governments as follows. First, production expansion that would be profitable for price-taking firms may result in lower prices, lower revenues, and lower profitability. This phenomenon is known as the "adding-up" problem and was first introduced to the economics literature by Harry Johnson and Jaghdish Bhagwati in the 1950s. Second, decisions to tax producers will also affect international prices, with a portion of the tax burden borne by international consumers. Deciding the correct level to tax producers is the "optimal tax" problem. Third, the extent of real exchange rate changes on the balance-of-trade may be small since changes in export revenue may offset export volume changes for commodities facing an "adding-up" problem. Finally, regionally optimal production levels and tax levels are different from country-specific levels. Imposing a tax which is optimal for the region across all countries within the region will not maximize the welfare of the countries in the region unless transfers are made among the countries. This paper systematically examines the markets for the major agricultural commodities that are of primary importance to Sub-Saharan Africa (SSA) for evidence of an "adding-up" problem. Few SSA countries individually face an "adding-up" problem. However, in the cases of cocoa in Cote d'Ivoire and, to a lesser extent cocoa in Ghana, tea in Kenya, and burley tobacco in Malawi, new investments are likely to affect international prices.

Where an "adding-up" problem does exist, export taxes rather than export quotas should be used Such taxes must be constantly evaluated as the underlying determinants--exchange rates, production costs, prices, and market shares-- change. Further, since agricutlure is frequently heavily taxed, implicit taxes -- such as over-valued exchange rates-- should be considered as well. The extent to which an "adding-up" problem does exists depends on marginal revenue effects relative to marginal costs. As a result,

government programs which encouraging production through area expansion will have a different effect on welfare than programs encouraging more efficient methods of production such as the development of improved varieties.

At a practical level, the analysis suggests that often the export tax level does not need to be calculated precisely, since the primary effect of setting the export tax anywhere in the neighborhood of the optimal tax is to transfer revenues from producers to the government, rather than to affect total welfare. As a result, the primary effect of setting export taxes at a less-than-optimal level is to provide more resources to farmers and the agricultural sector at the expense of government revenue. This characteristic is especially important when the crop is grown by low-income smallholders.

The coordination of tax policies and production levels regionally in Sub-Saharan Africa faces severe problems, both in terms of implementation and equity. Policies that would reduce output levels regionally would benefit larger, often wealthier, African countries at the expense of smaller countries. Also, in many instances, regions outside Sub-Saharan Africa, especially Latin America and Asia, would receive the primary benefits from such an arrangement.

1. Introduction

Sharp declines in world agricultural commodity prices and in real revenues (income terms of trade) generated by the important export commodities from Sub-Saharan Africa (SSA) have led to concern over the export prospects for the region. A real price index for SSA's major agricultural export commodities shows a decline of 4.2% per annum (p.a.) since the late 1970s. SSA's income term of trade for agricultural commodities declined at 4.2%, while, during the same period, the agricultural income term of trade for Asia increased at 1.7% (Table 1).

Table 1: Growth rates of income terms of trade for selected regions, 1975-90.

Region	Nine major SSA commodities – % p.a. –	Total Agriculture – % p.a. –
Asia	-1.7	1.7
Latin America	-3.9	-1.8
Sub-Saharan Africa	-4.2	-4.2

Source: FAO and IECIT, World Bank

A feature of SSA's agricultural commodity exports is that a few commodities account for a large share of total agricultural commodity exports – the top five export crops account for about two-thirds of total agricultural commodity exports -- and this share has been increasing over time. The decline in Sub-Saharan Africa's agricultural income terms of trade and the increasing concentration of SSA's agricultural commodity exports has raised anew the issue of the "adding up" or fallacy of composition problem.

The "adding up" problem has been discussed widely, especially in the context of primary commodity export strategies for SSA countries. Since many SSA exports face price-inelastic demand, an increase in export quantities can potentially reduce overall export revenues from these commodities and lower the general economic welfare of the country. However, there seems to be confusion as to the practical implications of an adding-up problem for commodity production and export policies. Because the formulation of strategies is of great importance for Sub-Saharan Africa, clarification of the issues in terms of theoretical and empirical analysis is needed. Hence, the main focus of the paper is to identify the nature and extent of the adding-up problem in Sub-Saharan Africa and to suggest appropriate commodity policies for the region.

Following this introduction, Section 2 reviews the characteristics of SSA's agricultural commodity exports. Section 3 defines the adding-up problem and provides an empirical measure of the problem for primary commodity exports in Sub-Saharan Africa. Section 4 examines how the adding-up problem can complicate a number of standard policy-related problems. Section 5 concludes.

2. Agriculture Export Earnings in Sub-Saharan Africa

Sub-Saharan Africa is dependent on a few primary commodities for export earnings. For many countries, this dependence has not changed significantly over three decades. Since the 1960s when agriculture averaged over 20% of world trade, the importance of agricultural trade world-wide has diminished such that, for the 1988 to 1990 period, agriculture accounted for less than 10% of world trade. Yet agricultural products comprise more than 25% of export earnings in 29 African countries. Agricultural exports account for 50-75% of export earnings in eight countries, and for more than 75% in eight countries (see Table 2). Further, many of those countries no longer dependent on agriculture are instead dependent on a non-agricultural primary commodity. For example, Angola and Nigeria rely almost exclusively on petroleum exports; Zaire and Zambia earn most of their export earnings through copper exports; and Botswana relies heavily on the export of diamonds.

Table 2: SSA countries dependency on agriculture for export earnings

Agriculture's share of export earnings (1988-90 average)

Less than 25%	25-50%	50-75%	75-100%
Angola	Benin	Cote d'Ivoire	Burundi
Botswana	Central African Republic	Cameroon	Ethiopia
Congo	Cape Verde	Guinea-Bissau	Mali
Gabon	Ghana	Kenya	Malawi
Guinea	Gambia	Madagascar	Rwanda
Equatorial Guinea	Burkina Faso	Sao Tome & Principe	Sudan
Mauritania	Liberia	Chad	Somalia
Malawi	Lesotho	Tanzania	Uganda
Niger	Mozambique		
Nigeria	Mauritius		
Senegal	Swaziland		
Sierra Leone	Togo		
Seychelles	Zimbabwe		
Zaire			
Zaire			
Zambia			

Source: FAO

One or more of a set of nine agricultural crops--bananas, cocoa, coffee, cotton, groundnuts, rubber, sugar, tea, and tobacco--are of primary importance in at least one country in Africa and together these commodities account for about 70-76% of agricultural exports for the region. This statement has been true for three decades as can be seen in Table 3. Table 4 provides the share of total export earnings

derived from these nine agricultural crops for each SSA country. The most striking dependencies are in Burundi, Ethiopia, Malawi, Rwanda, and Uganda. Table 5 shows each country's reliance on exports from each of the nine commodities The exclusive dependence of Burundi and Uganda on coffee has been a constant feature of those economies across decades. In some cases, notably tobacco in Malawi, or tea in Kenya, the dependence has been increasing rather than diminishing.

Table 3: Share of Sub-Saharan Africa's agricultural export earnings by crop, 1961-90

	1961-1969	1970-1979	1980-1989	1988-90
Bananas	1.3	0.7	0.5	0.7
Cocoa	16.1	20.6	21.9	19.5
Coffee	19.2	25.9	26.7	20.5
Cotton	10.0	9.1	8.5	12.0
Groundnuts	10.9	5.5	2.1	2.5
Rubber	2.6	1.7	2.1	3.0
Sugar	4.0	4.7	5.8	7.0
Tea	2.1	2.6	3.7	4.2
Tobacco	3.9	3.2	4.8	6.4
Nine major crops	70.0	74.1	76.0	75.9

Source: FAO

While many SSA countries remain highly dependent on the export of a few agricultural commodities, the world has become less dependent on exports from Sub-Saharan Africa (Table 6). While banana exports may be vitally important to Somalia, banana exports from all of SSA now constitute less than 3% of world trade in bananas whereas in the 1960s their share was 9%. Groundnut exports are important in that thinly traded market; however, groundnut exports are trivial in the larger market for oilseeds and oilseed products. Cocoa is the only major agricultural commodity for which Sub-Saharan Africa produces more than one-half of world production.

Table 4: Share of total export earnings from nine major crops, by country, 1961-90

Country	1961-69	1970-79	1980-89	1988-90
		%		
Angola	48.5	27.0	3.9	0.5
Burundi	74.9	90.9	90.3	87.9
Benin	23.9	51.3	31.6	33.4
Botswana	1.8	0.2	0.0	0.0
Central African Republic	47.0	45.4	27.1	25.1
Cote d'Ivoire	62.5	57.7	56.5	53.2
Cameroon	70.0	61.6	49.8	48.8
Congo	14.8	8.3	1.0	0.9
Cape Verde	25.9	11.5	18.4	28.4
Ethiopia	60.7	56.3	66.1	61.7
Gabon	1.9	0.6	0.4	0.3
Ghana	70.4	69.8	49.4	44.9
Guinea	21.4	7.9	2.9	2.8
Gambia	92.9	89.1	45.3	39.6
Guinea-Bissau	59.8	56.9	20.5	6.2
Equatorial Guinea	.	87.0	44.2	21.4
Burkina Faso	13.8	37.5	43.3	35.0
Kenya	29.7	40.3	45.9	46.3
Liberia	22.3	17.6	25.2	26.8
Madagascar	44.5	40.2	42.8	27.2
Mali	21.9	39.4	35.2	47.3
Mozambique	40.1	34.1	21.1	11.2
Mauritius	92.7	79.4	45.8	32.2
Malawi	81.4	82.8	84.8	88.6
Niger	67.5	12.9	0.3	0.6
Nigeria	46.9	6.3	2.5	2.9
Rwanda	54.8	74.9	81.6	80.7
Sudan	63.5	67.0	46.0	49.4
Senegal	75.4	45.2	18.3	19.5
Sierra Leone	5.8	16.7	25.0	15.4
Somalia	39.9	16.5	12.7	28.1
Sao Tome & Principe	73.4	75.8	70.4	50.3
Swaziland	29.2	34.9	36.4	29.1
Seychelles	.	0.1	0.0	.
Chad	67.1	39.1	35.4	48.0
Togo	53.0	37.3	31.6	30.7
Tanzania	33.5	44.1	52.2	49.2
Uganda	72.3	89.2	95.9	94.1
Zaire	11.3	13.5	17.0	11.4
Zambia	1.2	0.8	1.1	1.0
Zimbabwe	26.4	25.2	32.1	32.1
Sub-Sahara Africa(non-oil)	38.0	37.2	29.8	26.4
Sub-Sahara Africa	39.8	25.4	18.8	18.3
World	5.9	3.4	2.1	1.5

Source: FAO and IECIT, World Bank

Table 5: Share of export earnings from important export crops in selected SSA countries, 1961-90

	1961-69	1970-79	1980-89	1988-90
Bananas				
Cape Verde	17.6	11.3	18.2	27.9
Somalia	39.6	16.5	12.7	28.1
Cocoa				
Cote d'Ivoire	21.3	24.9	33.0	31.4
Cameroon	30.3	27.4	19.5	17.8
Ghana	69.8	69.3	49.3	44.6
Equatorial Guinea		70.4	40.5	19.2
Soa Tome & Principe	70.6	75.0	70.1	50.2
Coffee				
Burundi	66.8	84.6	84.6	80.8
Central African Republic	19.8	26.9	18.3	17.0
Cote d'Ivoire	36.4	29.2	17.8	13.0
Cameroon	25.2	27.2	23.9	20.0
Ethiopia	57.8	52.9	63.8	60.1
Kenya	17.8	26.2	25.6	21.6
Madagascar	30.1	34.2	37.0	20.9
Rwanda	52.8	66.5	71.2	65.1
Tanzania	13.7	23.1	31.0	22.8
Uganda	43.6	72.4	93.3	90.6
Cotton				
Benin	7.8	24.8	20.8	31.6
Burkina Faso	9.9	29.1	42.6	34.7
Mali	7.2	28.6	32.8	45.4
Sudan	53.3	53.3	38.0	43.2
Chad	66.8	39.0	35.3	47.7
Togo	3.9	1.6	10.4	16.9
Tanzania	15.2	13.2	12.1	15.9
Groundnuts				
Gambia	92.9	89.1	44.4	36.9
Senegal	75.3	42.9	16.0	17.7
Rubber				
Liberia	19.8	13.6	19.1	24.5
Sugar				
Mauritius	90.7	77.3	44.3	36.9
Swaziland	27.8	32.9	34.9	28.8
Tea				
Kenya	10.8	13.3	19.4	24.6
Malawi	27.0	19.0	16.2	11.7
Rwanda	2.5	8.5	10.4	15.6
Tobacco				
Malawi	37.3	47.3	51.6	64.4
Zimbabwe	22.8	13.9	18.8	20.2

Source: FAO

Table 6: Share of SSA exports in world trade, by selected commodities and aggregates, 1961-90

Country	1961-69	1970-79	1980-89	1988-90
Bananas	9.0	5.9	2.9	2.8
Cocoa	67.4	59.6	47.4	44.5
Coffee	24.5	27.1	21.9	19.2
Cotton	12.1	12.8	10.9	12.9
Groundnuts	61.1	39.0	18.4	20.4
Rubber	6.9	5.6	5.1	6.1
Sugar	5.7	4.5	4.5	5.2
Tea	8.7	14.9	15.3	14.9
Tobacco	9.4	8.5	10.1	12.5
Nine Major crops	17.9	17.7	14.8	13.9
Total agriculture	7.1	5.7	3.7	2.9
Total trade	2.7	2.4	1.6	1.2

Source: FAO

The dependency on a few agricultural commodities for export earnings often reflects a dependency on agriculture in the country's economy. Table 7 provides the agriculture's share of GDP in countries with available data. In many countries agriculture generates such a large portion of the country's annual income that policies and programs targeting commodity and agricultural sub-sectors become vitally important for the economy as a whole.

Table 7: Agriculture's share of GDP for selected countries in Sub-Saharan Africa

Country	1970	1980	1990
		per cent	
Benin	37	34	38
Botswana	25	14	6
Cameroon	37	28	27
Congo	21	15	13
Comoros	.	.	41
Cape Verde	.	14	13
Gabon	.	9	9
Ghana	54	56	47
Guinea	.	.	26
Guinea-Bissau	66	39	46
Mali	55	50	47
Rwanda	42	47	37
Senegal	28	22	21
Seychelles	.	6	4
Chad	46	54	38
Togo	30	26	36
Zambia	10	10	11

Source: International Economics Department, World Bank.

Price volatility is a characteristic of commodity prices and dependence on commodity exports generally translates into volatile export revenues. Figure 1 illustrates the effects of commodity price movements in trade data from SSA. The top line in the graph is the income terms of trade (the value of exports deflated by a price index of manufactured exports from G-5 countries--the Bank's MUV) for total trade. The high level and volatility of the index throughout much of the 1970s was notably due to the development of oil production in Nigeria combined with the two oil shocks of that decade. Excluding Nigeria from the aggregate data (the second line from the top), the effect of the "commodity boom" of the 1970s is less pronounced. The third line from the top is an index based on the export value of the nine major agricultural export crops in SSA, while the bottom line is an index for all agricultural exports. These indices are characterized by a sharp peak in 1977 and then a precipitous drop that was somewhat reversed in the mid-1980s and a continued decline thereafter. While the decline from 1977 to 1980 was sharp, it occurred from historically high price levels. The most recent decline from 1986 to the present is a decline from what might be considered, in a historic sense, average income terms of trade levels.

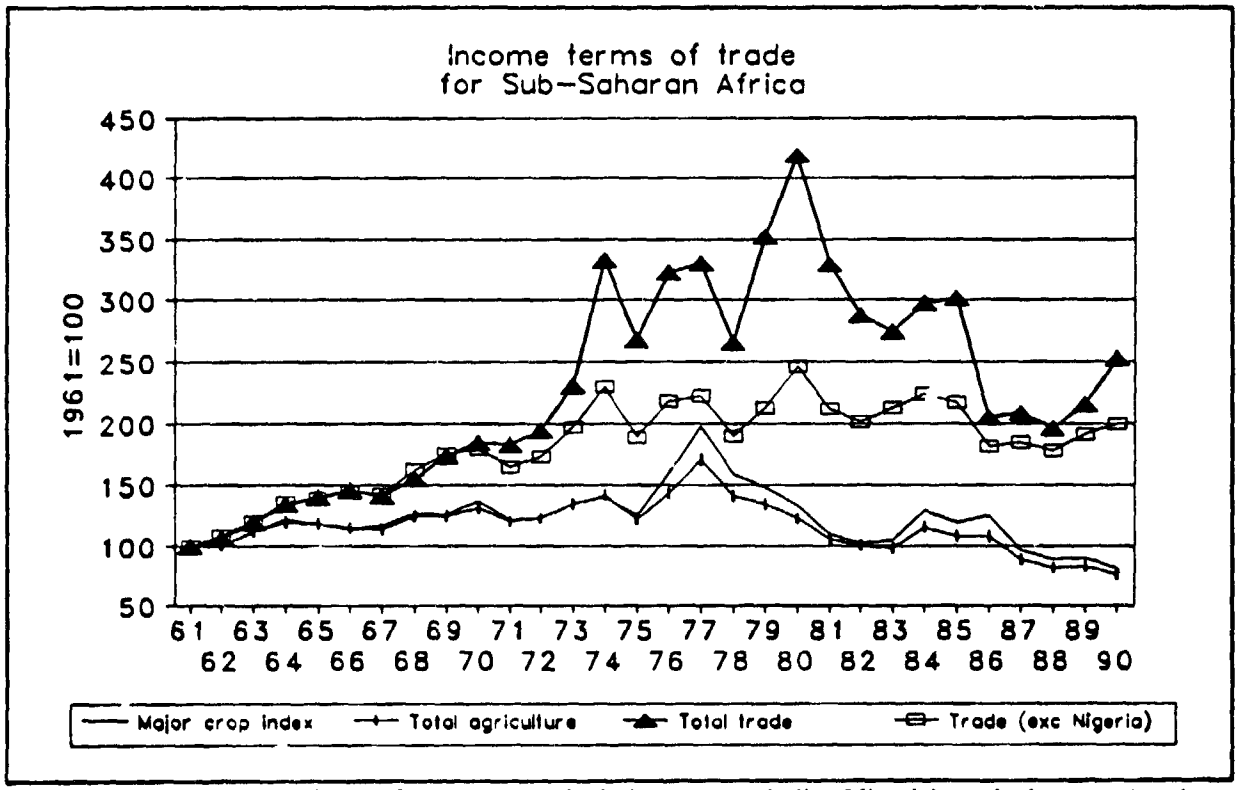

Figure 1: Income terms of trade for total trade (including and excluding Nigeria), agriculture, and major SSA commodities.

Figure 2 compares indices of income terms of trade based on the nine major SSA commodities for the Latin American, Asian, and SSA regions. For the group of commodities important to Africa, the experience of SSA has not been radically different from the experience of Asia or Latin America--although large differences did occur in specific crops and in specific countries. While the income terms of trade for Asia have been more stable than for Latin America and Africa, all three regions have experienced a substantial deterioration in the terms of trade for this group of crops since the mid 1970s. For agriculture as a whole, however, a different story emerges (see Figure 3). In SSA the nine commodities represent a large proportion of total agricultural exports so that an income terms of trade index for total agriculture follows fairly closely the path of the nine-commodity index, falling sharply after 1977. In Asia and Latin America, the export performance of other crops resulted in improving income terms of trade in the case of Asia, and a less dramatic decline in the case of Latin America.

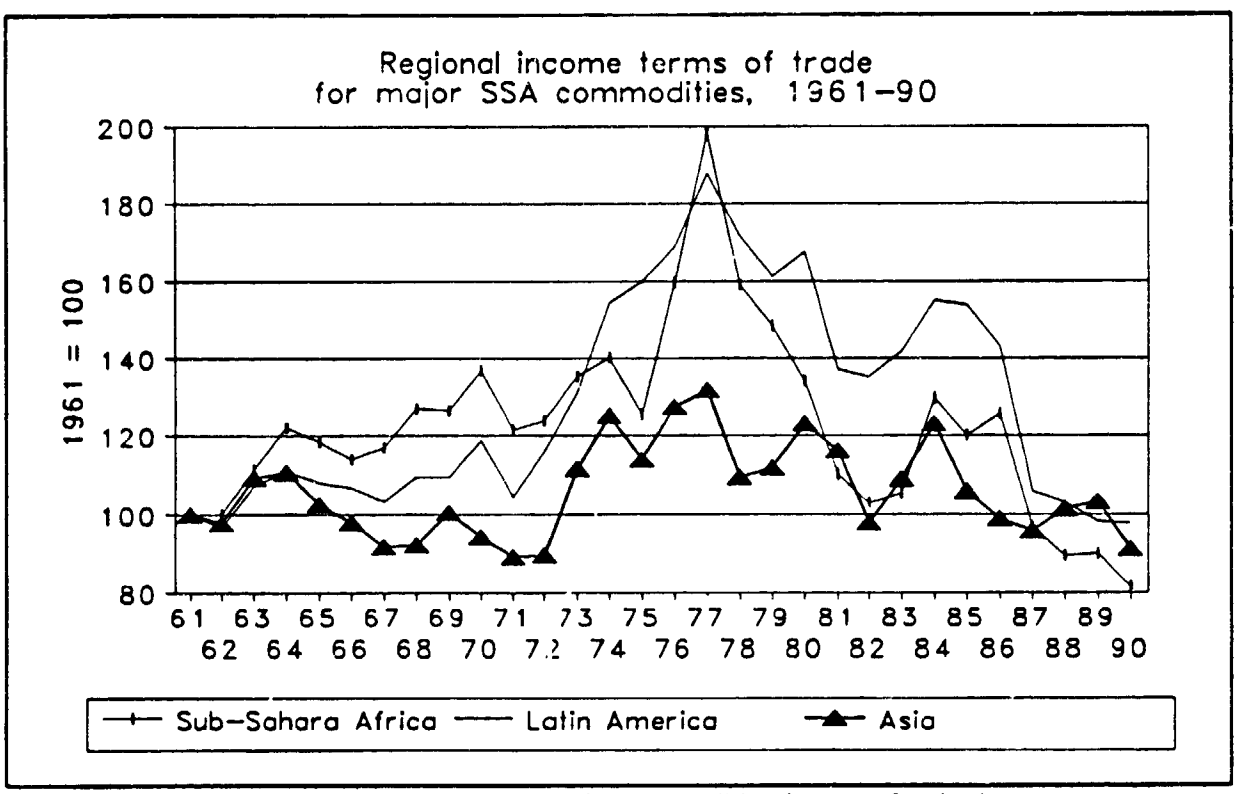

Figure 2: Regional income terms of trade for the nine commodities that are of major importance to Sub-Saharan Africa.

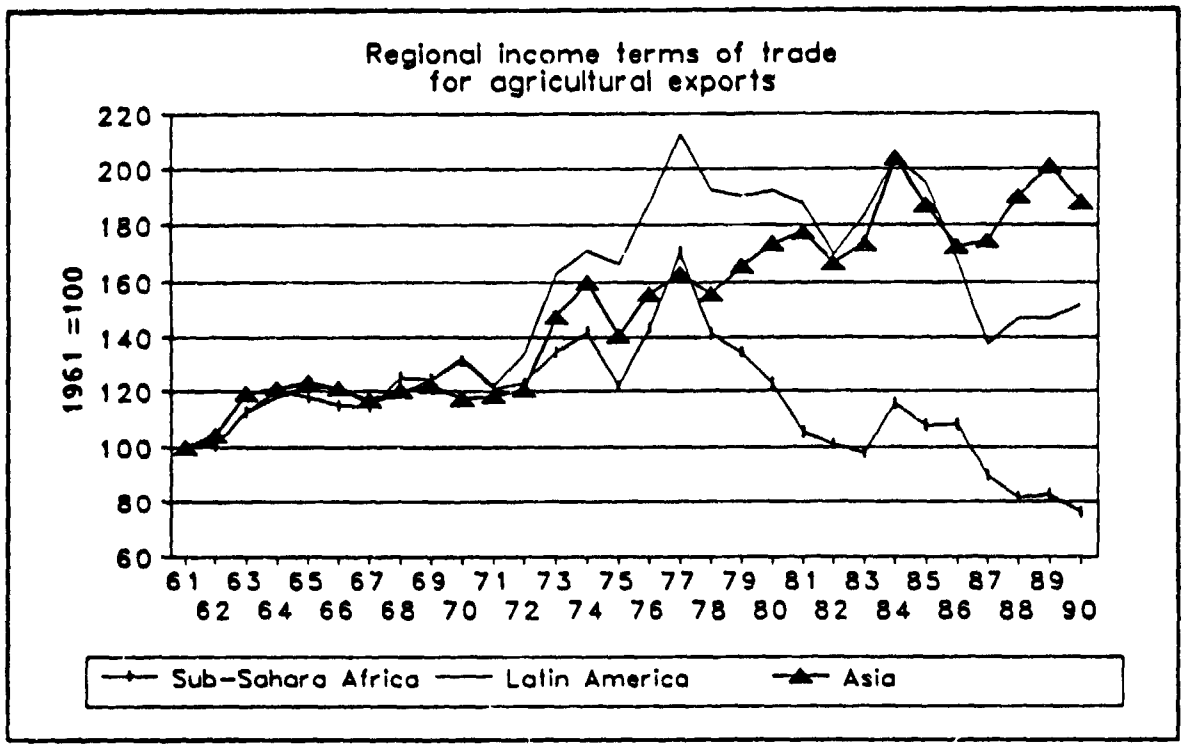

Figure 3:: Regional income terms of trade for agriculture.

In both Asia and Latin America, non-traditional crops expanded while the composition of exports from SSA remained fairly stagnant (Figure 4). In Latin America (see Figure 5) the dominance of coffee in export earnings gave way to expanding exports of fruits, vegetables, and oilseed products--primarily soybeans and soybean meal. In Asia (see Figure 6), productivity increases affected all sectors of agriculture with the largest gains coming from fruits and vegetables and the dramatic increase in palm oil exports from Malaysia and Indonesia.

While we have focused on the more relevant measure, the income terms of trade which includes the effect of production gains, there may be some interest in purely price terms of trade. Figure 7 plots the barter terms of trade (a nominal price index deflated by the MUV) for the nine major export crops. Two sets of commodity prices were used to derive indices.[1] The index given in the top line in the graph is based on observed spot market prices taken as indicative of world prices. The second is an average of SSA export unit values based on FAO export quantity and value data. The advantage of the former is that the prices can be more readily observed without error. Yet very little trade may be associated with such prices

[1] There are also choices in the mechanics of constructing a price index. A Fisher index, which is the geometric average of Laspeyres and Paasche indices, is reported here. However, the barter terms of trade did not prove sensitive to indexation and either a Laspeyres or Paasche index would provide similar results.

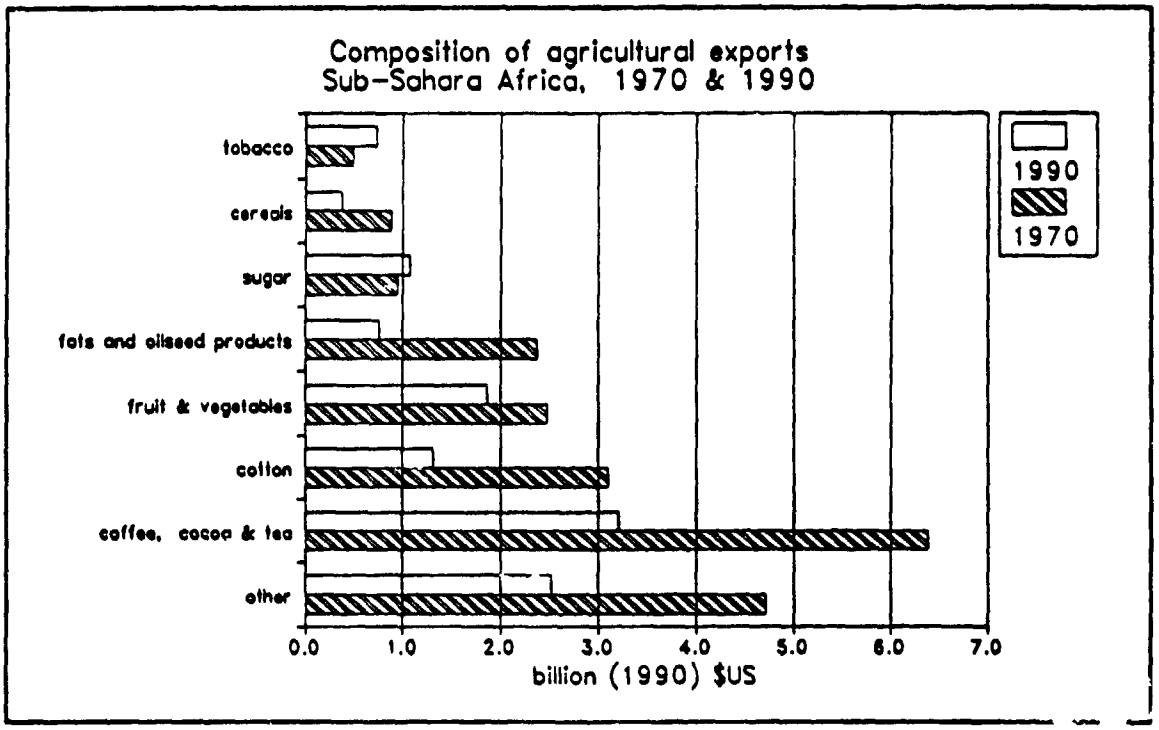

Figure 4: Composition of agricultural exports form Sub-Saharan Africa for 1970 and 1990.

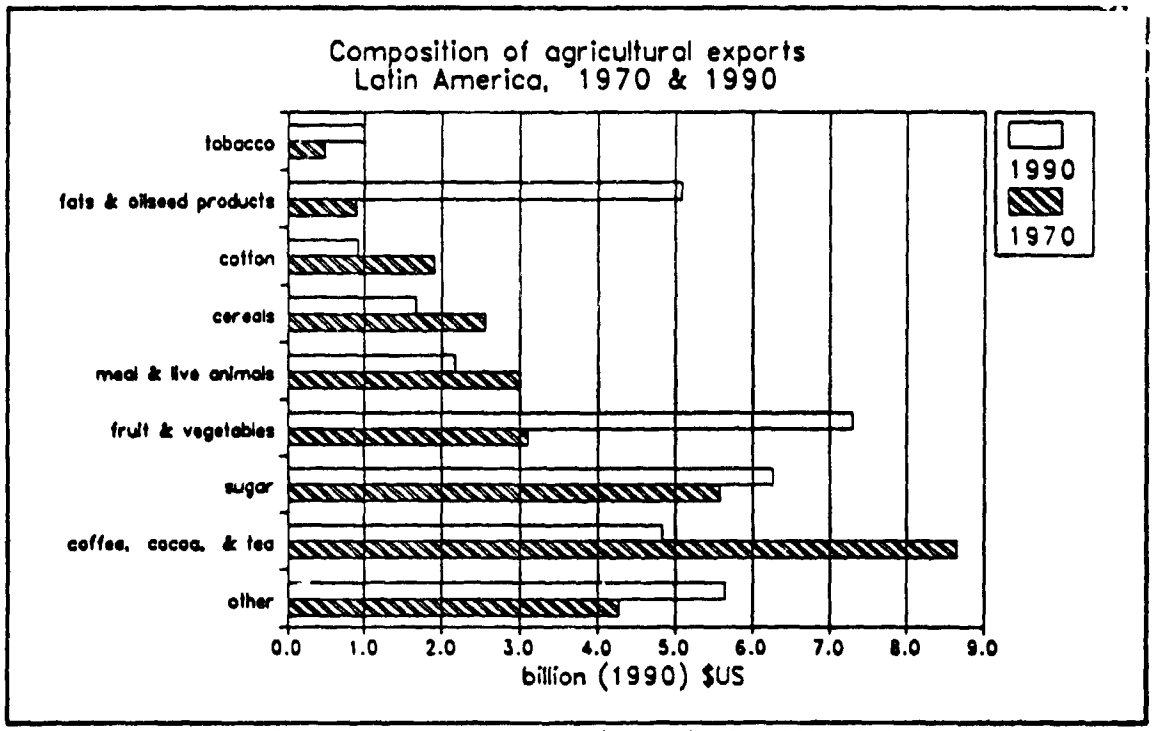

Figure 5: Composition of agricultural exports from Latin America for 1970 and 1990.

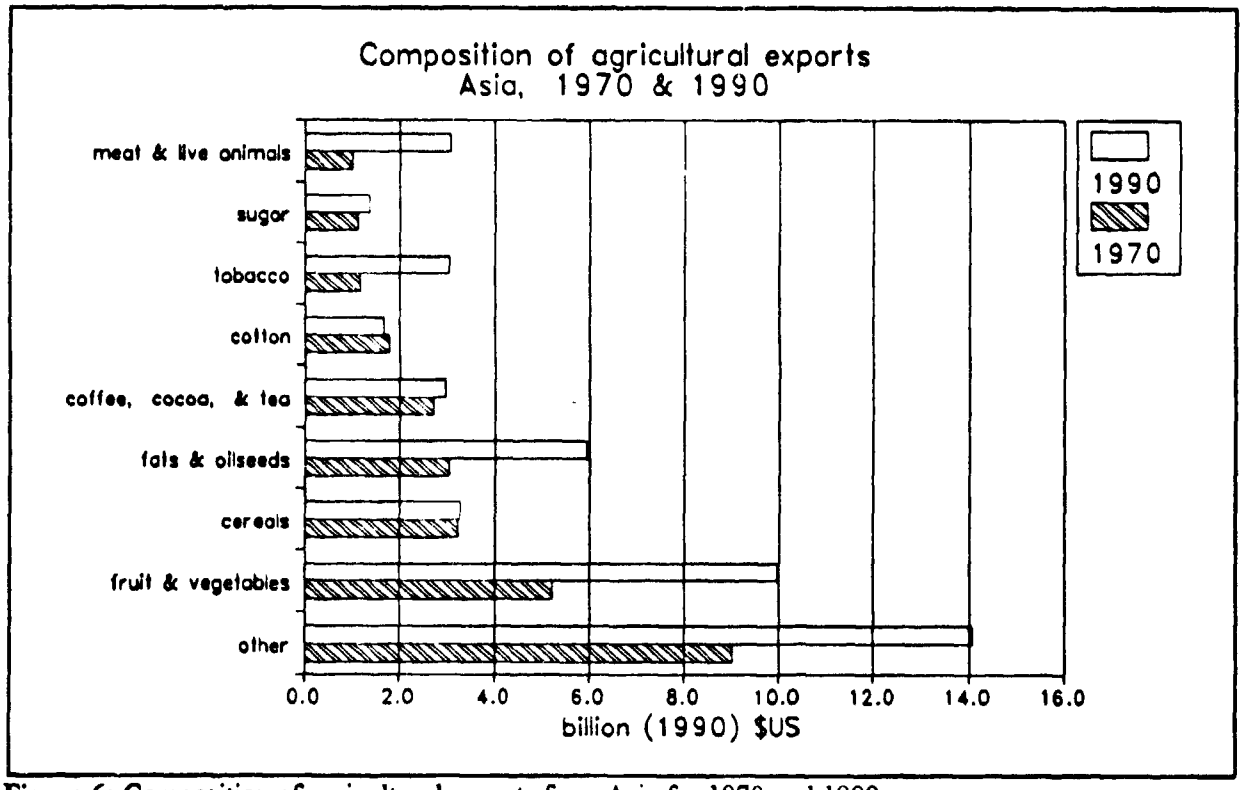

Figure C: Composition of agricultural exports from Asia for 1970 and 1990

and unit values could more accurately reflect actual earnings. There are some important differences between the two sets of indices. Conspicuous by their absence are price spikes in 1963, 1974, and 1980 for the barter terms of trade based on export unit values. Decomposition of the index revealed that these were the result of sharp peaks in the world price for sugar that failed to show up in SSA export earnings. Nonetheless, in both series, real commodity prices declined during the past decade.

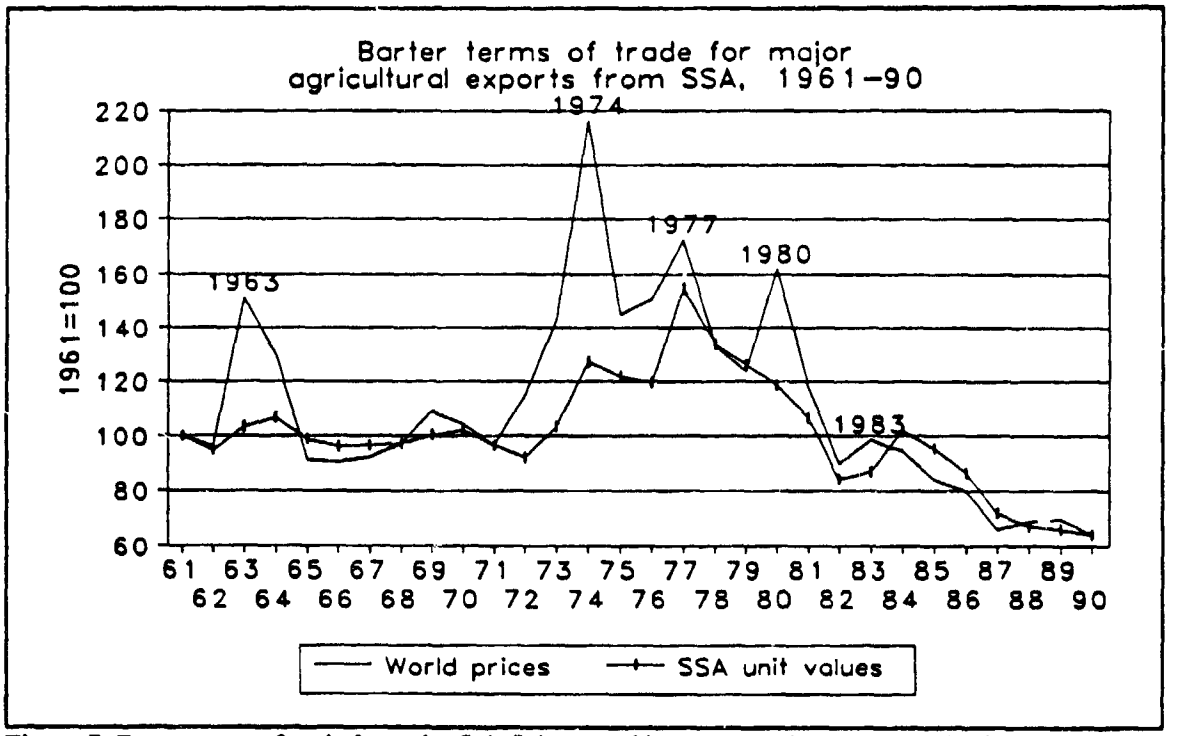

Figure 7: Barter terms of trade for major Sub-Saharan African commodity exports, valued at international market prices and at average export price

3. The Adding-up Problem in Sub-Saharan Africa

The adding-up problem occurs because individuals can produce small amounts of a commodity without affecting world prices, although their additional collective supplies can drive down world prices. Individual producers will continue to produce to the point where marginal cost equals the world price, while the profit maximizing point, from the perspective of country-wide welfare, is where marginal cost equals marginal revenue. Stated another way, the adding-up problem arises when a country fails to fully exercise any market power its producers collectively possess.

The problem was first discussed in the context of immiserizing growth by Jagdish Bhagwati (1958) and Harry Johnson (1955). Bhagwati proved that economic growth could be immiserizing in the presence of the adding-up problem. More recently, the paradox of immiserizing growth was proven to be more general and arises from a sub-optimal allocation of resources. (See for example, Bhagwati, Brecher and Hata, 1984; and Hata, 1984.) Still, issues relating to the adding-up problem, especially in the context of primary commodities, remain hotly debated because the optimal policies prescriptions rest on hard-to-measure empirical parameters.

The adding-up problem can be described mathematically by starting with the producer problem of maximizing profits over time:

$$\max_{p} \; E_o \int_o^t [\, ps^h - C(s^h)\,] e^{-rt} dt \quad s.t.\; d^w = s^h + s^{row} \qquad 1)$$

that is, the producer maximizes the expected discounted stream of profits, where p is price, s^h are home-country sales, c is the cost of production, and r is the discount rate. The problem is constrained by the fact that the home-country sales and sales from the rest of the world (s^{row}) must equal world demand (d^w).

The solution to the problem is given by[2]:

$$-J_t = Max_p E\left[p\left(d^w - s^{row}\right) - C\left(d^w - s^{row}\right)\right] \qquad 2)$$

[2]Brock and Malliaris, 1989, pp.352-55, provide a good summary of dynamic optimization issues.

The first-order condition is given by:

$$d^w - s^{row} + p(d_p^w - s_p^{row}) - C'(d_p^w - s_p^{row}) = 0. \quad 3)$$

Noting that $s^h = d^w - s^{row}$, and rearranging (3) provides:

$$\frac{d^w - s^{row}}{d_p^w - s_p^{row}} = p - C' \quad 4)$$

Dividing both sides by p and by dividing the numerator and denominator of the LHS by d^w provides the optimal tax condition:

$$\frac{m^d}{m^{row}\varepsilon_s^{row} - \varepsilon_d^w} = \frac{p - C'}{p} = T^* \quad 5)$$

where $\varepsilon_d^w < 0$ is the elasticity of demand, $\varepsilon_s^{row} > 0$ is the supply elasticity for the rest of the world, $m^d = s^d / d^w$ is the market share of the home country and where $m^{row} = 1 - m^d$ is the market share of the rest of the world. T^* defines the optimal tax rate.

Expressed in terms of (5), the adding-up problem occurs when the individual marginal producer produces to the point where price equals marginal cost. Generally this is sub-optimal and a non-zero export tax will increase over-all returns to the country. However, as a practical matter, the optimal tax is often zero because of small market share or because other producers can easily expand production. In terms of the optimal-tax condition, the optimal export tax approaches zero when the market share of the home country (m^h) shrinks, when the supply responsiveness of competitors (ε_s^{row}) increases, and when demand becomes more elastic (when - ε_d^w increases).

To see how the various parameters of the model affect the choice of the optimal tax, a simple model was constructed of the type used to calculate optimal tax rates reported later in the paper. Constant-elasticity supply curves for the home country and the rest-of-the-world were specified along with a world-wide constant-elasticity demand curve. A world price and home-country price were solved via the adding-up constraint that total supply and demand must match. As a result, market share, which is a function of home-country and rest-of-the-world supplies, is endogenous as well. As a starting point, the home country

was assumed to have about a 25% share of the world market; the world demand price elasticity was set at -0.4; and the home country and the rest-of-the-world both supply elasticities were set at 0.9.

Figure 8 show the effects of changing the assumed demand elasticity on the optimal tax rate (left-hand axis) and the equilibrium market share (right-hand axis). As the demand elasticity rises, the optimal tax rate declines. However, since the decline in the tax rate rises home-country prices and home-country supplies, the equilibrium market share for the home-country rises as well, partially off-setting the first-order effect on the tax rate.

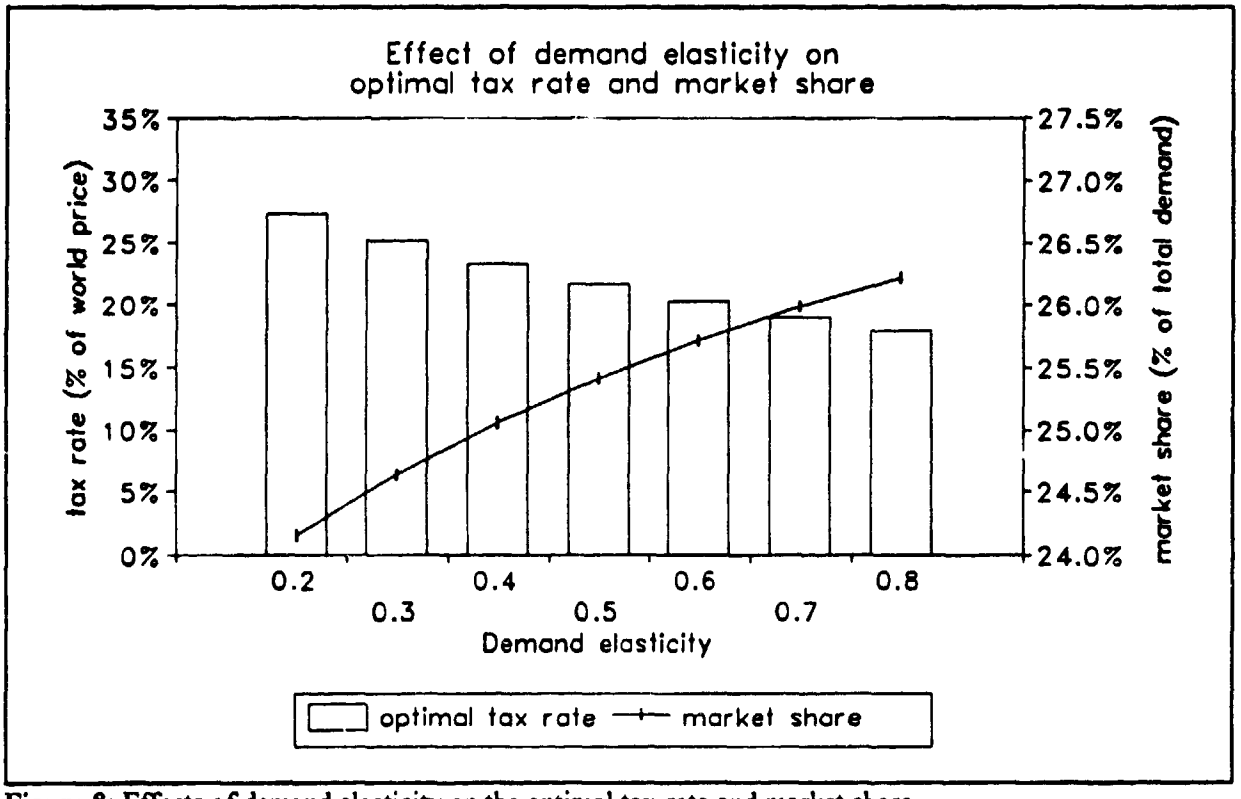

Figure 8: Effects of demand elasticity on the optimal tax rate and market share.

Figure 9 maps out the effects of changing the supply elasticity of the rest-of-the-world, while holding the home-country elasticity constant at 0.9. The net-effects are similar to increasing the demand elasticity. The first and primary effect is to push down the optimal tax rate which increases domestic prices and increases the home country's market share.

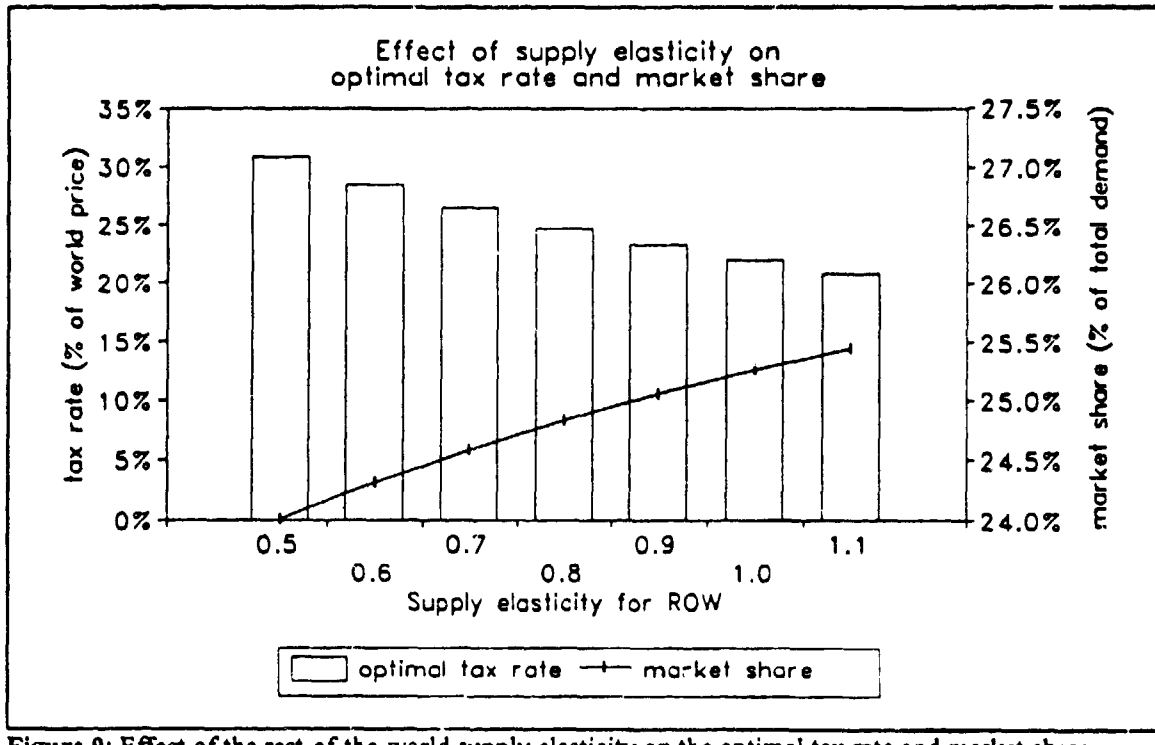

Figure 9: Effect of the rest-of-the-world supply elasticity on the optimal tax rate and market share.

Finally, Figure 10 maps the effect of changing the home country's supply elasticity while holding the supply elasticity constant at 0.9 for the rest-of-the-world. Unlike the other parameters, the optimal tax rate is not very sensitive to alternative home-country supply elasticities. Instead, the primary effect is on market share which declines as home-country supplies become increasingly inelastic.

The adding-up problem can be stated in terms of the elasticity of export revenue with respect to volume (ERV). This is a convenient concept, since it relates to the market power of the home country. Since the revenue generated by exports (sales) is $R(s^h) = ps^h = p(d - s^{row})$, $ERV = 1 + \frac{\partial p}{\partial q}\frac{q}{p}$ so that:

$$ERV = 1 + \frac{1}{\eta} = 1 - \frac{p - C'}{p} = 1 - t^e \qquad 6)$$

where the entity $\eta = (\varepsilon_d^w - m^{row}\varepsilon_s^{row})/m^h$ is the price elasticity of demand facing a country (see, for example, Imran and Duncan). Therefore the ERV is bound somewhere between 1 (when the market share of the home country is nearly zero, and 0 (since the marginal cost of production cannot be negative).

Although the adding-up problem usually centers on commodities (Martin, 1993 is one of the exceptions), there is no reason from theory that the adding-up problem be a commodity problem. Still, the

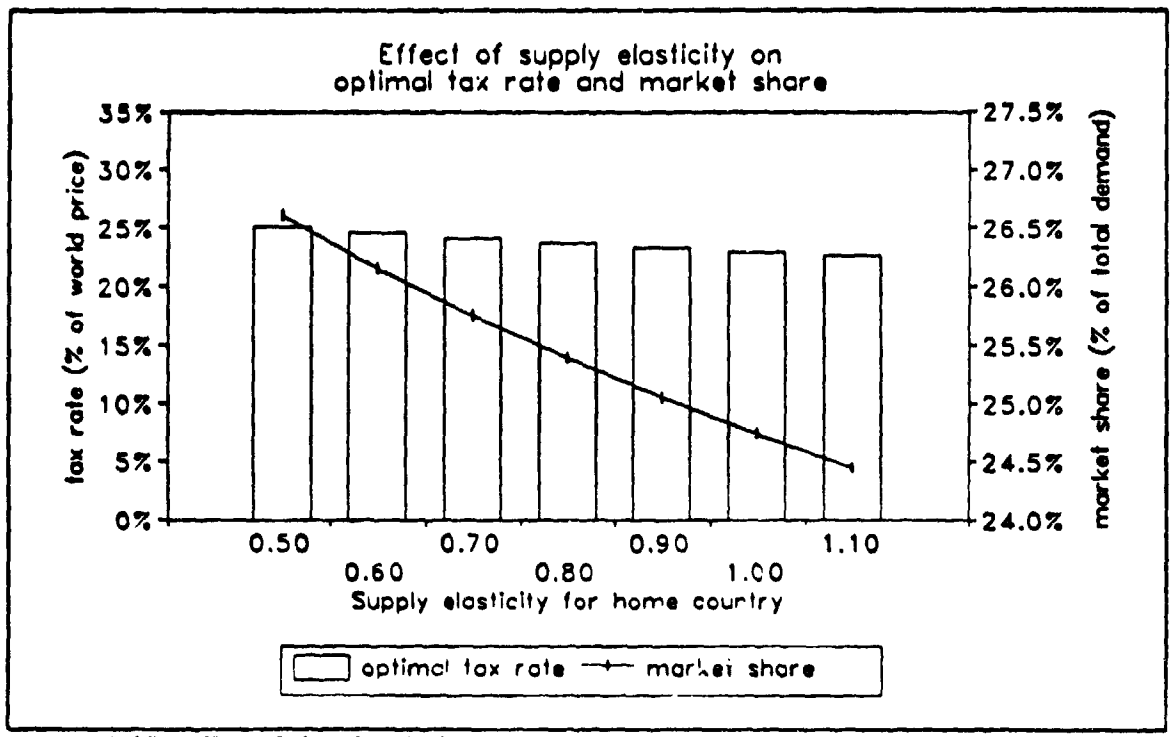

Figure 10: The effect of changing the home-country supply elasticity on the optimal tax rate and market share.

raw material costs in the final-consumption form for many commodities is quite low. For example, the tax on a cigarette in most countries greatly exceeds the cost of the raw tobacco contained in the cigarette. As a result, a very large decline in the price of a commodity like tobacco may result in a very small decline in the price of the form in which the good is finally consumed such as cigarettes or cigars. Since very large price changes result in very small changes in consumption, these goods tend to have low demand price elasticities. Additionally, several countries and regions have concentrated market shares. These features suggest that adding-up problems are likely to occur in commodity markets. Further, since several raw commodities are especially important in several countries in Sub-Saharan Africa, optimal pricing becomes an urgent policy and development issue.

In much of the literature on the adding up problem, Sub-Saharan Africa is treated as a single region. As will be discussed in the next section, that approach leads directly to fundamental difficulties in terms of policy implementation. Still, that approach has been taken in initially calculating estimates of the regional adding-up problem for SSA, as reported in Table 8. The table shows estimates of the short- (2 to

3 years) and long-term (7 to 10 years) ERVs based on SSA's market shares in world production, for agricultural commodities in which SSA holds a sizable share of the world market (see Annex Tables 1-6 for greater detail). Since adjustments such as production expansion for perennial crops takes time, long-run strategies should be based on long-run ERVs. Basing the analysis on SSA as a single entity generates lower ERVs (and higher optimal tax rates) than does an analysis based on single country shares. Still, ignoring for the moment implementation issues, the adding-up problem for Sub-Saharan Africa appears limited to cocoa, coffee, tea, and tobacco

Cocoa faces the most serious adding-up problem. In the short run, the ERV for cocoa is negative, implying that SSA export revenues will fall with an increase in exports. Even in the long run, it is not profitable for SSA to produce cocoa unless the production cost of the additional output is less than 33% of the world price. Coffee, tea, and burley tobacco may face an adding-up problem in the short-run, but it is not nearly as serious as for cocoa. It is profitable to increase production for these commodities so long as the production cost of the additional output is less than about 80% of the world price.

Table 8: Export revenue elasticities and optimal export tax for selected commodities in Sub-Saharan Africa

Commodity	share	demand elasticity short	demand elasticity long	supply elasticity short	supply elasticity long	ERV estimate short	ERV estimate long	optimal tax (%)
Cocoa								
SSA	54.5	-0.30	-0.40	0.35	0.90	-0.19	0.33	67.3
Cote d'Ivore	29.8	-0.30	-0.40	0.35	0.90	0.45	0.71	28.9
Ghana	11.2	-0.30	-0.40	0.35	0.90	0.82	0.91	9.3
Nigeria	6.5	-0.30	-0.40	0.35	0.90	0.90	0.95	5.2
Cameroon	5.1	-0.30	-0.40	0.35	0.90	0.92	0.96	4.0
Coffee								
SSA	20.7	-0.30	-0.40	0.35	0.80	0.64	0.80	20.0
Cote d'Ivore	4.3	-0.30	-0.40	0.35	0.80	0.93	0.96	3.7
Ethiopia	3.3	-0.30	-0.40	0.35	0.80	0.95	0.97	2.8
Uganda	3.0	-0.30	-0.40	0.35	0.80	0.95	0.97	2.6
Zaire	1.7	-0.30	-0.40	0.35	0.80	0.97	0.99	1.4
Tea								
SSA	16.3	-0.30	-0.40	0.25	0.70	0.68	0.83	16.6
Kenya	10.3	-0.30	-0.40	0.25	0.70	0.80	0.90	10.0
Malawi	2.1	-0.30	-0.40	0.25	0.70	0.96	0.98	2.0
Burley Tobacco								
SSA	10.6	-0.10	-0.50	0.50	0.80	0.79	0.87	12.6
Malawi	9.0	-0.10	-0.50	0.50	0.80	0.84	0.93	7.3
Cotton								
SSA	5.4	-0.15	-0.30	0.30	0.90	0.88	0.95	4.7
Sudan	0.7	-0.15	-0.30	0.30	0.90	0.98	0.99	0.6
Cote d'Ivoire	0.7	-0.15	-0.30	0.30	0.90	0.99	0.99	0.6
Sugar								
SSA	3.7	-0.20	-0.30	0.45	0.80	0.94	0.97	0.5
Mauritius	0.7	-0.20	-0.30	0.45	0.80	0.99	0.99	0.4

4. The Effect of the Adding-Up Problem on Trade Policy

Policies suggested for regions facing an adding-up problem include diversification (Godfrey, 1983; Stewart, 1991), taxation (Stewart), and production quotas (Stewart). Usually, these policies imply reduced incentives for traditional export crops in SSA. However, an important consideration often ignored in the analysis is whether, in fact, SSA should be treated as a single economic unit. It is clear that Cote d'Ivoire faces a serious adding-up problem with regard to cocoa because of its large world market share (30%). But should countries such as Togo or Benin which individually do not face an adding-up problem adopt policies aimed at discouraging cocoa production? Further, it is not clear that it is necessary or even beneficial to encourage diversification by penalizing traditional exports.

In the past, policies explicitly or implicitly discouraging the production of primary commodities have often led to adverse and lasting consequences in SSA. Examples include Ghana's cocoa policy and Nigeria's policies affecting palm oil in the 1970s. Policies or events which constrain traditional exports often spur investment in other countries. Should diversification prove unsuccessful, it leaves SSA with considerably less total export revenue than before. For example, in response to the decline in Ghana's cocoa production in the 1970s, Brazil, Cote d'Ivoire, and Malaysia expanded their production substantially.

Five issues pertinent to countries in which exports are concentrated or face an adding-up problem are discussed in detail below--export taxes, coordination of policies among SSA countries, diversification, the effect of extension services and production increases on welfare, and exchange rates policies.

Export Taxes

As discussed earlier, export taxes can maximize welfare from exports of a commodity for a country which has some measure of monopoly power. The optimal level of the export tax is that which, at a country level, equates marginal cost with marginal revenue when the commodity is produced by a large number of smallholder farmers who otherwise perceive the world price as their marginal revenue. The optimal tax level in a static framework is the inverse of the price elasticity of demand facing the country.

Calculation of the optimal tax level dynamically becomes considerably more complicated especially in the case of perennials which require more than one year of investment for production.

Still a prominent characteristic of the relationship between the export tax and welfare from the commodity (as measured by the sum of producer surplus and government tax revenues) is that the country's welfare remains little changed over a wide range of export tax rates around the optimal rate. An example of the change in welfare under different export tax rates is shown in Figure 11. This is the case of a country with a world market share of 12%. The optimal level of the export tax is 15%. Assumptions are that the world price elasticity of demand is -0.35 and the supply elasticity of all producers is 0.5 The total welfare hardly changes for tax rates of 0 to 40%. Simulations with different market shares produced similar results. However, the distribution of income between the producers and the government changes drastically with changes in the export tax. Figure 11 also shows, as theory predicts, that export revenue is at a maximum when the export tax is zero.

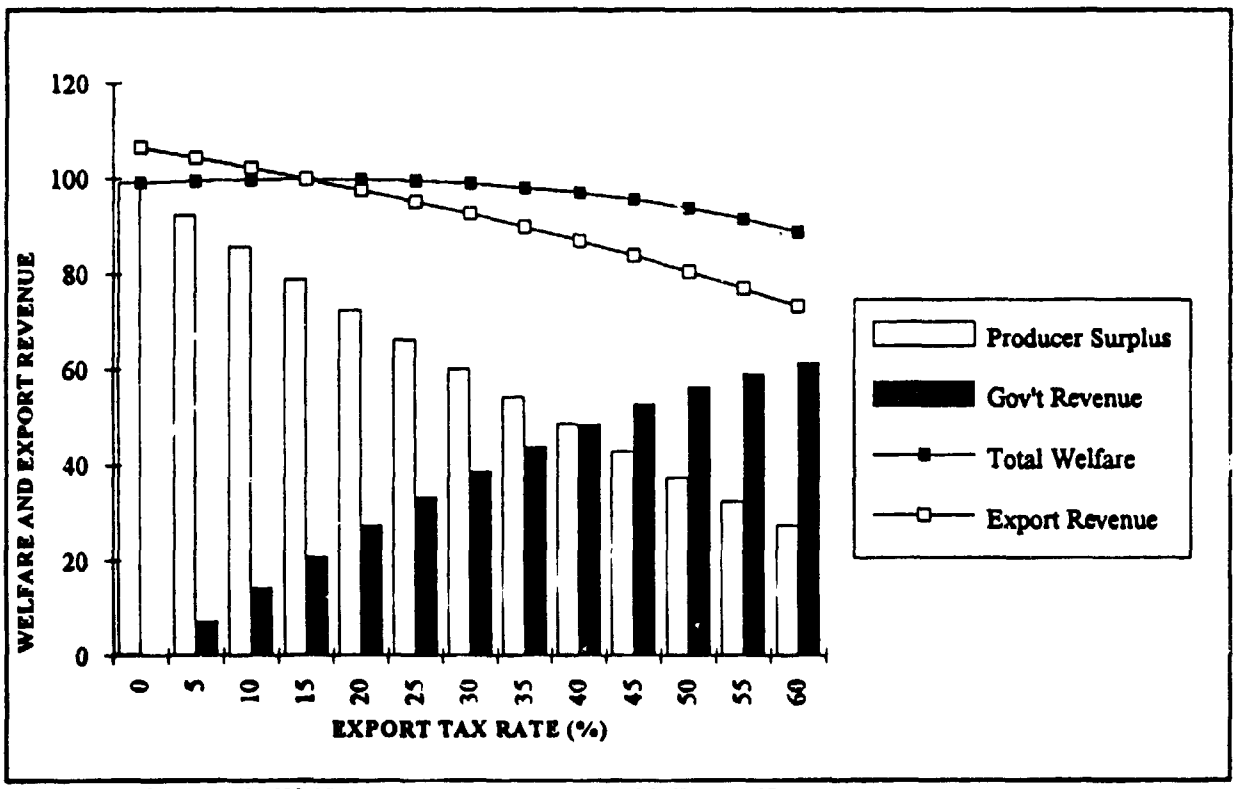

Figure 11: Changes in Welfare and Export Revenue with Export Tax

For perennial crops, because production is dependent on investments (new plantings), lower taxes result in higher long-term production potential. Hence, the level of the optimal tax is critically dependent on the discount rate used. For example, if a zero export tax was implemented for five years in the above example of a country that has a 12% world market share, the country's welfare would be slightly less than the maximum in the short run but its welfare would be large in ten years.

The discussion above suggests that the level of the export tax can be set within a fairly wide range without significantly affecting total welfare. This is an important point in practice, since high export taxes may not be practical. High export taxes encourage high rates of evasion either through smuggling or bribes. In addition, the tax may prove regressive if it places a high burden on low-income smallholders. If a country decides to impose an export tax, it is critical that the level be examined frequently. The optimal tax level changes with changes in the market share and in price elasticities of demand and supply.

Another consideration in examining export taxes is the degree to which the commodity is directly or indirectly subsidized or taxed along the production chain. Because of their traditional place in many economies, policies regarding trade and production have frequently generated layers of institutions working at cross purposes. On the one hand, traditional export crops often receive preferential treatment in the allocation of extension services and transportation services which amounts to an indirect subsidy. More directly, producers are sometimes offered guaranteed prices above world market rates backed with public funds. At the same time, cesses are often levied directly or indirectly to finance over-staffed marketing boards. In the case of cocoa, Stryker et. al. (1990) found that the Ghanaian cocoa marketing board operations implicitly taxed cocoa at a rate of 20-50% from 1955 to 1985 — a rate much higher than the 9-10% optimal tax calculated in Table 8. Additionally, over-valued exchange rates also serve as an indirect tax on exports and an indirect subsidy on input imports. Such an over-valuation can arise from direct exchange-rate controls, but can also arise indirectly — for example from import restrictions (See Krueger, Schiff and Valdez, 1991). Export taxes should not be placed as an additional layer on a complex structure of subsidization and taxation, but rather in place of often conflicting policy instruments.

Coordination of policies among SSA countries

Because export revenues can be increased, at least in the short-run, by reducing world exports of commodities that have price elasticities of less than unity, there have been a number of attempts to construct international commodity agreements to raise commodity prices. There are at present international agreements for natural rubber, coffee and cocoa but the economic provisions of the latter two are not operative. The economic provisions of the International Cocoa Agreement to stabilize world cocoa prices were based on buffer stock operations, but after a few years of operations in the early 1980s, the buffer stock fund was depleted due to rapidly increasing world cocoa production. The export quota system of The International Coffee Agreement stopped operating in July 1989 when members of the Agreement could not reach an agreement on the rules of operation for the quota system. The International Natural Rubber Agreement is based on an international buffer stock system, but international rubber prices have been hovering at the bottom of the support range for the last several years. Recent experience with international commodity agreements supports the notion that, as a practical matter, it is impossible to support world prices above a market-clearing level for a sustained period of time. Williams and Wright (1992) and Larson and Colemen (1991) both discuss the predisposition of commodity management schemes to fail due to price movements. An additional problem is the asymmetric distribution of benefits arising from such schemes. The coordination of tax policies survey SSA countries would face this same obstacle.

To illustrate the difficulty of operating a policy in which all SSA countries imposed the same export-tax rates, a simple model was built to evaluate the effects of export taxes imposed at the optimal rate by two countries, independently and jointly. World demand elasticity was assumed to be -0.35 and all supply elasticities were assumed to be 0.5. There are three producers -- Country 1 with the market share of 10%, Country 2 with a market share of 25%, and the rest of world (ROW). All production is assumed to be exported. Table 9 shows changes in key variables when export taxes are set at the optimal level for each country independently and when they are considering Country 1 and 2 as one unit.

Table 9: Changes in key variables when two countries move from taxing exports based on country shares to a uniform regional tax based on combined market share.[a/]

	per centage change
World market	
Supply	-1.9
Price	5.7
Rest of the world	
Welfare	8.6
Export revenue	8.6
Market share	3.1
Country-level effects of moving to a uniform regional tax-rate	
Country 1 (small)	
Producer surplus	-48.0
Government revenue	214.3
Total welfare	-1.5
Export revenue	-15.0
Market share	-1.8
Country 2 (large)	
Producer surplus	-19.5
Government revenue	31.8
Total welfare	3.3
Export revenue	-1.7
Market share	-1.3
Regional effects of moving to a uniform regional tax-rate	
Country 1 & 2 combined:	
Producer surplus	-29.5
Government revenue	54.9
Total welfare	2.0
Export revenue	-5.5
Market share	-3.1

a/ If imposed independently, the optimal tax rates are 12.6% and 34.7% for Countries 1 and 2, respectively. If imposed jointly, the optimal regional tax rate is 46.5% because of the larger market share. See the text for assumptions made.

The simulation results show several interesting facts when the two countries impose the tax jointly, including:

(i) The combined welfare of the two countries increases but by only small margin. In this example, the increase is only 2%.

(ii) Because of the higher export tax, i.e., 46.5% compared with 12.6% and 34.7% when imposed independently, the producer surplus of both countries declines sharply; the producer surplus of the smaller country declines considerably more than that of the larger one. The government revenue of both countries increases sharply, especially that of the smaller one.

(iii) Total welfare of the smaller country declines while that of the larger country increases.

(iv) Market shares and export revenues of both countries decline. The reduction is considerably greater for the smaller country than for the larger country.

(v) Welfare, export revenues, and market share of ROW increase substantially.

The simulation results point to an obvious difficulty in coordination around the question of whether the large country will be willing to compensate for the loss incurred by the small country. Because the combined welfare is increased, the larger country would still gain after compensating the loss incurred by the smaller country. Possibly a more important problem is that the welfare, export revenue, and market share of the rest of the world increase significantly. In this example, the welfare gain by ROW is 8.6% while that by the two countries combined is only 2%. In the long-run, this would enable the rest of the world to increase productivity and its market share even further.

Diversification

As mentioned above, some analysts argue that diversification should be a priority in the context of SSA's agricultural export strategies of SSA countries facing adding-up problems. However, given that in many SSA countries, a large number of people are engaged in production, processing, and marketing of the major commodities and that these commodities are the only cash crops, it is difficult for any economic development strategy to be viable if these commodity subsectors are ignored or penalized. Diversification usually requires investment and often the only source of the capital is the traditional crop subsectors. As discussed below, it is possible to increase the producer surplus and government export tax revenue from the commodity facing an adding-up problem through productivity increases. Such a strategy may be a viable option for diversification in many SSA countries. Even though it puts additional government resources into the subsector, just as a profitable and dynamic agricultural sector often complements industrialization—a profitable and dynamic traditional commodity subsector can facilitate the development of a viable diversified agricultural sector.

A forced diversification strategy that ignores the relative profitability of new commodities vis-à-vis traditional commodities is likely to fail. There is no guarantee that diversification in and of itself will

increase the welfare of SSA countries. For example, some commodities for which SSA does not face an adding-up problem may also have very poor price prospects because of declining demand or sharply increasing supply of countries outside of the region. Additionally, Sub-Saharan Africa may lack a comparative advantage in producing those commodities. Diversifying into these commodities might make Sub-Saharan Africa worse off when compared to increasing productivity in traditional crops .

Alternatively, where alternati es do exist, appropriate export taxes on commodities facing an adding-up problem will provide incentives for diversification because relative prices would give appropriate incentives to farmers as to what crop to grow, either for domestic consumption or export. Additionally, there has been a frequent bias in government spending in many SSA countries in favor of traditional export crops in terms of research, extension, marketing and distribution infrastructure, which has worked against the establishment and growth of other export activities. The reasons for this bias include government revenues from export taxes and the ease and speed with which production of traditional export crops can be increased compared with non-traditional ones. Removing biases in government services will also encourage the development of alternatives to traditional crops.

The effects of extension services and technical change

Some analysts discussing the adding-up problem for SSA countries appear to suggest that these countries and the international community should do nothing for these commodities and instead allocate resources to diversification. Such advice often stems from a confusion over price effects, profitability and welfare. Changes in applied technology that result in a fall in international prices can still lead to welfare increases. But careful analysis is required on how productivity or production is increased because the different way in which productivity or production is increased has different implications for the country's welfare.

The relationship between productivity or production increase and welfare has been widely discussed in the economic literature.[3] Any productivity and production increase can be classified into three

[3] See for example, Lindner and Jarrett (1978) and Voon and Edwards (1992).

basic types depending on the way it shifts the supply curve in a price-quantity diagram—convergent, parallel, and divergent. (These three types are shown in Figure 12.)

It is clear from Figure 12(a) that the convergent type of supply shift does not increase production but increases farmers' welfare given by the area abc. Because this does not increase production, it has no impact on the world price. Hence in this case the question of "adding-up" problem does not arise. It is a pure case where the impact is just on increasing producer surplus of existing producers. Such a shift can occur, for example, when research and extension services are concentrated on efficient farmers. Small share-holders are often assumed to be the least efficient producers and programs that target efficient producers are opposed on equity grounds. This is may be a mistaken assumption and careful consideration should be given to the impact of training and extension programs.

In the case of a parallel shift of the supply curve, the welfare gain is positive. The welfare comparison is to be made between the areas of triangles aP_0f and bP_1g in Figure 12(b). Because the triangles are similar and $P_1g > P_0f$, area $bP_1g > aP_0f$. This type of shift increases supply and hence lowers world prices. This is the case when all farmers succeed in reducing production cost by the same amount. An example of such research is the development of yield-improving planting material.

The effect on welfare is uncertain in the case of a divergent supply shift (Figure 12(c)). This type of shift could occur, for example, if effort is given to reducing the production costs of the less efficient farmers while leaving production cost of the more efficient farmers unchanged. In such a case, the price decline resulting from making the marginal farmer more productive can result in an overall decline in surplus. As a practical matter, the instances when adding-up effects are significant are exceedingly rare. Nonetheless, unless off-set by increased tax-rates (in which surplus gains go to the government instead of producers) programs targeting the least efficient producers can be counter-productive.

In countries where an adding-up problem exists, extension and research programs which target inefficient farmers can generate a policy dilemma – especially if the least-efficient farmers are also the poorest. In terms of the optimal tax, recall that $T^* = (p - C')/p$, so that for the most marginal farmer, most, if not all, of the increased profits arising from cost-saving extension work must be taxed away by the

government. Otherwise, the country will produce in excess of the optimal level and total producer surplus will be reduced.

Fortunately, at a practical level, there are few instances where countries face an adding-up problem. Still, in those few cases where the problem does exist, care should be taken to recognize that the price-effect of increased production reduces the value of the service to the marginal farmer when inefficient

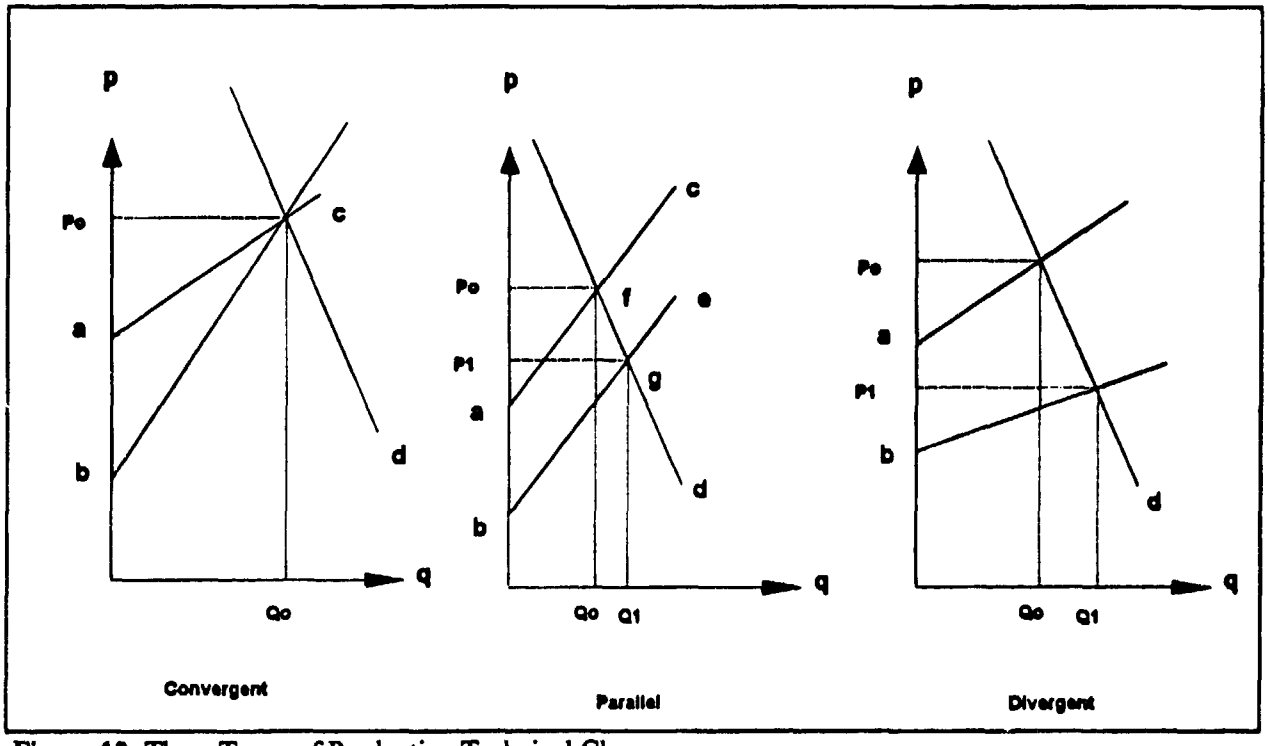

Figure 12: Three Types of Production Technical Change.

caused by extension and research work which unduly emphasizes traditional crops at the expense of alternatives.

Finally, when an adding-up problem does exist, programs devoted to area expansion, such as subsidized planting schemes may result not only in a misallocation of land resources, but may also result in welfare losses. Unlike the example of cost-reductions for inefficient farmers which can be off-set through increases in the tax-rate, area expansion is likely to result in either constant or increasing marginal costs. In the presence of an adding-up problem, the additional quantities reduce prices as well, generating a net loss in government and producer surplus.

Exchange Rates

In examining appropriate exchange rate setting for countries whose major export items are agricultural commodities facing an adding-up problem, two critical factors need to be taken into account--exchange rates of competing countries and the marginal revenues of the incremental production caused by the exchange rate change.

As discussed by Devarajan et al (1993), the most common approach in practice to estimating the equilibrium exchange rate is to calculate the "purchasing power parity" (PPP) equilibrium exchange rate. According to this approach, the equilibrium nominal rate is calculated by equating the inflation adjusted value of the country's currency to that of trading partners. As Devarajan et al point out, this approach has major flaws if there are major changes in relative world prices of commodities and in the equilibrium level of foreign capital inflows. For a country whose major export items are primary commodities, the relevant comparison is between the country's real exchange rate and those of competing countries.

An example could be an SSA country whose main export item is cocoa and its main destination is Western Europe. Assume that this country's imports consist mainly of capital goods from Western Europe. According to the PPP approach, this country's real exchange rate should follow the real exchange rate of Western Europe. However, if real exchange rates of other major cocoa producing countries such as Malaysia and Indonesia depreciate significantly relative to Western European currencies, the SSA country will lose its competitiveness in exporting cocoa. The prime consideration in determining the real exchange rate level for such countries therefore should be movements in production costs of the major export commodities as compared with other major producing countries expressed in a common currency.

The ERV is a critical parameter in evaluating the exchange rate of a country that faces an adding-up problem. For such a country that depends heavily on a single export commodity and faces a balance-of-payment problem, a real devaluation would not help to alleviate the balance-of-payment problem unless the devaluation leads to the substantial expansion of exports of other commodities. This is because a devaluation would increase supply and hence exports of the traditional commodity but would not increase export revenues much due to the low ERV. In such countries, it becomes indispensable to impose a tax on

the traditional commodity to enhance the expansion of other exports. From experience, this is a common situation as the supply response of new exports is very slow--most likely because investors are unsure that the reform policies will be long-lasting.

A devaluation cannot decrease profitability of producing export commodities. For a given output, proportional increase in revenues and costs will result in a proportional increase in profits. In practice, however, a change in exchange rates will affect the relative profitability of alternative production methods. A devaluation increases the price for imported inputs such as pesticides, machinery, and some fertilizers while only indirectly affecting the price of "non-tradable" inputs. Since a variety of farming methods is frequently used within a single country, the effect of devaluation on farm profitability will not be the same for all farmers. To this extent, changes in relative prices have an effect on supplies similar to changes in the underlying technology. If inputs are generally imported, and low-cost producers are input-intensive, then an exchange rate devaluation tends to flatten the supply curve. This would be a divergent type of production increase in Figure 12. Low-cost producers will see an upward shift in costs and a decline in profits, while low-input high-cost producers see little change in their (already high) costs. The devaluation in this circumstance will lead to increased production since revenues are increased while the effects on marginal costs are more limited. However, a portion of the producer surplus previously enjoyed by the high-input users is lost to increases in input prices. Alternatively, if low-input producers are also low-cost producers, a devaluation has an effect similar to the introduction of a convergent technology of Figure 12 and low-cost producers will enjoy an increase in producer surplus. Generally, it is likely that relatively high-input technologies are also low-cost. This is because there are no constraints to not using inputs if it is cost-effective to do so while delivery systems, trade restrictions, or lack of credit may all hamper input use even when it is cost-effective. Care should be taken however in analyzing the specific technologies available in the country and to recognize the relationship between technologies, exchange rates, and prices. When low-cost production is also input-intensive, potentially large gains in producer surplus may be available when obstacles to input-use are removed for high-cost producers through credit or extension programs. At the same time, the potential gains to such programs may be reduced when the currency of the country is constantly devalued.

5. Concluding Remarks

The paper examined agricultural commodity strategies for SSA countries with a focus on the adding-up problem. The adding-up problem has been raised frequently because of the poor performance of SSA's agricultural commodity exports and the increasing concentration of exported commodities in the last 15 years. However, the analysis shows that only a few countries in SSA individually face this problem. The problem is a serious one for Cote d'Ivoire in cocoa, and exists in a less serious form for Ghana in cocoa, Kenya in tea, and burley tobacco in Malawi.

Some analysts discuss the adding-up problem in terms of SSA as a whole and reasonably conclude there is a problem for cocoa, coffee, and tea. However, it does not appear feasible to design and implement agricultural commodity production and trade policies for the region as a whole because of the difficulty in coordinating policies to equitably distribute gains among SSA countries. In addition, the analysis suggests that if SSA countries agreed to impose the optimal export tax based on Sub-Saharan Africa as whole, the greatest benefit would go to producers in other regions such as Latin America and Asia. Recent failures of international commodity agreements and the disruption caused by their discontinuation highlight the difficulties of coordination of trade or production strategies among countries aimed at raising world prices.

Some analysts hint that production of commodities facing an adding-up problem should be discouraged. Instead, these subsectors create a resource base that can be used by farmers and governments to create dynamic and diversified agricultural sectors. Given that these commodities are often the only cash crops in which the countries have a comparative advantage, it would be counter-productive to design an agricultural strategy based on discouraging production of these commodities.

The few countries that do face a serious adding-up problem need to take specific considerations in designing and implementing policies that affect production and exports of the commodity including:

(i) Increasing production through costly expansion of land area should be avoided. Such policies would likely reduce producer surplus of existing farmers because of their negative impact on world prices.

(ii) Efforts should be made towards reducing production and marketing costs. If accompanied where appropriate by an export tax, this would not lead to much increase in production but would increase farmers' profitability and government revenues.

(iii) The analysis suggests that when an adding-up problem does not exist, a zero export tax would be the most appropriate policy for the long-term benefit of the subsector. Alternatively, when countries do face a serious adding-up problem, the imposition of an export tax near the optimal level would be the most efficient way to limit domestic production. Because the optimal export tax level changes with world market conditions, it is imperative that the export tax level be reviewed frequently. The analysis in this paper shows that precise calculation of the optimal tax rate is frequently not necessary since the primary effect of choosing various tax rates in the neighborhood of the optimal level is to allocate revenue between producers and the government. Taxing exports at a less-than-optimal level often results in additional revenue for the agricultural sector without affecting total welfare.

(iv) Imposition of an export tax could be desirable if a country facing a serious adding-up problem is to implement a real devaluation of its currency. One of the most important expected effects of a real devaluation is to adjust the balance-of-payments toward equilibrium. However, a real devaluation would increase production and exports of the commodities facing a severe adding-up problem. Since increased export quantities do not increase export revenues when an adding-up problem exists, an export tax on the commodity could be required to enhance export revenues by diverting resources from traditional commodities which faces adding-up problem to other commodities.

(v) Biases which favor traditional crops should be eliminated as well as policies which penalize. Diversification can be encouraged by providing equal access to transportation and extension services which have historically favored traditional crops.

Annex Table 1: ERV, and Optimal Tax of SSA Countries Producing Coffee

	1989	1990	Production Average 1989 & 1990	Production Share in SSA	Production Share in World	Demand Elasticity Facing Country		ERV		Optimal Tax
	(000 tons)		(000 tons)	(%)		(short)	(long)	(short)	(long)	(%)
SSA	1235	1282	1258	100.0	20.7	-2.8	-5.01	0.64	0.80	20.0
Cote d'Ivoire	239	284	262	20.8	4.3	-14.8	-27.11	0.93	0.96	3.7
Ethiopia	200	204	202	16.1	3.3	-19.2	-35.36	0.95	0.97	2.8
Uganda	174	192	183	14.5	3.0	-21.3	-39.11	0.95	0.97	2.6
Zaire	107	98	102	8.1	1.7	-38.3	-70.49	0.97	0.99	1.4
Kenya	105	95	100	7.9	1.6	-39.3	-72.35	0.97	0.99	1.4
Cameroon	86	102	94	7.5	1.5	-41.6	-76.73	0.98	0.99	1.3
Madagascar	88	83	86	6.8	1.4	-45.9	-84.52	0.98	0.99	1.2
Tanzania	58	52	55	4.4	0.9	-71.9	-132.53	0.99	0.99	0.8
Rwanda	39	45	42	3.3	0.7	-93.8	-173.10	0.99	0.99	0.6
Burundi	32	35	33	2.6	0.5	-119.4	-220.19	0.99	1.00	0.5

Source: IECIT

Annex Table 2: ERV, and Optimal Tax of SSA Countries Producing Cocoa

	Production Average 1989 and 90 (000 tons)	Production Share in SSA (%)	Production Share in World (%)	Demand Elasticity Facing country (short)	Demand Elasticity Facing country (long)	ERV (short)	ERV (long)	Optimal Tax (%)
SSA	1322	100.0	54.5	-0.8	-1.49	-0.19	0.33	67.3
Cote d'Ivoire	723	54.7	29.8	-1.8	-3.46	0.45	0.71	28.9
Ghana	271	20.5	11.2	-5.5	-10.76	0.82	0.91	9.3
Nigeria	158	11.9	6.5	-9.7	-19.12	0.90	0.95	5.2
Cameroon	123	9.3	5.1	-12.5	-24.77	0.92	0.96	4.0
Togo	8	0.6	0.3	-196.1	-392.05	0.99	1.00	0.3
Equatorial Guinea	8	0.6	0.3	-209.9	-419.56	1.00	1.00	0.2
Sierra Leone	7	0.5	0.3	-226.5	-452.76	1.00	1.00	0.2
Zaire	6	0.5	0.2	-260.3	-520.33	1.00	1.00	0.2
Sao Tome & Principe	5	0.3	0.2	-350.0	-699.86	1.00	1.00	0.1

Annex Table 3: ERV, and Optimal Tax of SSA Countries Producing Cotton

	Production Average 1989 and 90 (000 tons)	Production Share in SSA (000 tons)	Production Share in World (%)	Demand Elasticity Facing Country		ERV		Optimal Tax
				(short)	(long)	(short)	(long)	(%)
SSA	957	100.0	5.4	-8.0	-21.4	0.88	0.95	4.7
Sudan	121	12.6	0.7	-65.8	-175.2	0.98	0.99	0.6
Cote d'Ivoire	118	12.3	0.7	-67.5	-179.8	0.99	0.99	0.6
Mali	98	10.2	0.6	-81.4	-216.9	0.99	1.00	0.5
Zimbabwe	81	8.5	0.5	-98.2	-261.9	0.99	1.00	0.4
Tanzania	71	7.4	0.4	-113.1	-301.4	0.99	1.00	0.3
Burkina Faso	62	6.5	0.4	-128.1	-341.5	0.99	1.00	0.3
Chad	60	6.3	0.3	-133.0	-354.5	0.99	1.00	0.3
Benin	47	4.9	0.3	-169.8	-452.6	0.99	1.00	0.2
Cameroon	43	4.5	0.2	-183.7	-489.6	0.99	1.00	0.2
Nigeria	38	4.0	0.2	-208.7	-556.3	1.00	1.00	0.2
TGO	34	3.6	0.2	-233.7	-623.2	1.00	1.00	0.2

Annex Table 4: ERV, and Optimal Tax of SSA Countries Producing Sugar

	Average 1989 and 90 (000 tons)	Production Share in SSA (%)	Production Share in World	Demand Elasticity Facing Country		ERV		Optimal Tax
				(short)	(long)	(short)	(long)	(%)
SSA	3918	100.0	3.7	-17.3	-29.21	0.94	0.97	3.4
Mauritius	596	15.2	0.6	-116.1	-196.38	0.99	0.99	0.5
Swaziland	502	12.8	0.5	-138.0	-233.45	0.99	1.00	0.4
Zimbabwe	497	12.7	0.5	-139.2	-235.55	0.99	1.00	0.4
Kenya	474	12.1	0.4	-146.3	-247.51	0.99	1.00	0.4
Sudan	400	10.2	0.4	-173.4	-293.47	0.99	1.00	0.3
Ethiopia	190	4.8	0.2	-365.8	-618.93	1.00	1.00	0.2
Malawi	176	4.5	0.2	-394.0	-666.76	1.00	1.00	0.1
Cote d'Ivoire	148	3.8	0.1	-469.5	-794.43	1.00	1.00	0.1
Zambia	140	3.6	0.1	-497.6	-842.05	1.00	1.00	0.1
Madagascar	119	3.0	0.1	-582.8	-986.32	1.00	1.00	0.1
Tanzania	111	2.8	0.1	-625.5	-1058.46	1.00	1.00	0.1

Annex Table 5: ERV, and Optimal Tax of SSA Countries Producing Burley Tobacco

	Production		Production			Demand Elasticity Facing Country		ERV		Optimal Tax
	1990	1991	Average 1990 and 1991	Share in SSA	Share in World					
	(000 tons)		(000 tons)	(%)		(short)	(long)	(short)	(long)	(%)
SSA	292.85	317.39	81.59	24.3	10.6	-4.8	-7.9	0.79	0.87	12.6
Malawi	64.02	75.01	69.52	20.7	9.0	-6.2	-13.6	0.84	0.93	7.3
Zimbabwe	5.89	7.89	6.89	2.1	0.9	-66.8	-144.9	0.99	0.99	0.7
Madagascar	1.55	1.55	1.55	0.5	0.2	-299.6	-649.4	1.00	1.00	0.2
Mozambique	1.15	1.15	1.15	0.3	0.1	-402.6	-872.7	1.00	1.00	0.1
Zambia	0.80	0.80	0.80	0.2	0.1	-579.0	-1,254.8	1.00	1.00	0.1
Zaire	0.66	0.66	0.66	0.2	0.1	-701.9	-1,521.2	1.00	1.00	0.1
Tanzania	0.55	0.55	0.55	0.2	0.1	-842.4	-1,825.5	1.00	1.00	0.1
Kenya	0.28	0.28	0.28	0.1	0.0	-1667.2	-3,612.5	1.00	1.00	0.0
Angola	0.20	0.20	0.20	0.1	0.0	-2317.6	-5,021.6	1.00	1.00	0.0

SOURCE: IECIT

Annex Table 6: ERV, and Optimal Tax of SSA Countries Producing Tea

	Production			Demand Elasticity Facing Country		ERV		Optimal Tax
	Average 1989 and 90 (000 tons)	Share in SSA (000 tons)	Share in World (%)	(short)	(long)	(short)	(long)	(%)
SSA	299.4	100.0	16.3	-3.1	-6.04	0.68	0.83	16.6
Kenya	188.8	63.1	10.3	-5.1	-9.99	0.80	0.90	10.0
Malawi	39.2	13.1	2.1	-25.5	-50.73	0.96	0.98	2.0
Tanzania	18.5	6.2	1.0	-54.3	-108.38	0.98	0.99	0.9
Zimbabwe	17.5	5.8	1.0	-57.5	-114.78	0.98	0.99	0.9
Rwanda	11.5	3.8	0.6	-87.9	-175.54	0.99	0.99	0.6
Mauritius	5.6	1.9	0.3	-179.1	-358.01	0.99	1.00	0.3
Uganda	5.6	1.9	0.3	-179.6	-359.01	0.99	1.00	0.3
Burundi	3.9	1.3	0.2	-259.3	-518.32	1.00	1.00	0.2
Zaire	3.1	1.0	0.2	-325.2	-650.25	1.00	1.00	0.2
Cameroon	2.6	0.9	0.1	-387.8	-775.43	1.00	1.00	0.1

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